

## **REMARKS**

### ***In the Drawings***

The Examiner has objected to the drawings under 37 CFR §1.83(a)

In response to the objection, new FIGS. 3A and 3B have been added to the drawings in a sheet 3/4 labeled "NEW SHEET." The previous FIG. 3 has been renumbered as FIG. 4.

New FIG. 3A illustrates the optimal gate timing for the detector gate pulse, and new FIG. 3B illustrates establishing the optimum detector gate pulse width.

Support for the new FIGS. 3A and 3B is found in at least paragraph [0031].  
***No new matter has been added to the Application by the addition of FIGS. 3A and 3B.***

Applicants respectfully submit that the drawings satisfy 37 CFR §1.83(a) and respectfully request acceptance of the NEW SHEET and REPLACEMENT SHEETS and withdrawal of the objection to the drawings.

### ***In the Specification***

Paragraphs [0008] and [0009] of the "Summary of the Invention" section have been amended to correspond to the amendments made to the claims.

Paragraphs [0013] and [0014] in the "Brief Description of the Drawings" section have been amended to accommodate the addition of new FIGS. 3A and 3B and the re-designation of the original FIG. 3 to be FIG. 4. Two new paragraphs have also been added that describe the new FIGS. 3A and 3B. The description of these new Figures is taken directly from paragraph [0031].

Paragraphs [0031]-[0033] and [0037] of the "Detailed Description of the Invention" have been amended to accommodate the changes to the new Figure numbering.

### ***In the Claims***

Claims 1-14 were originally pending in the Application. Claims 1, 6 and 12 have been objected to, and claims 1-14 have been rejected. Applicants note that two claims "12" were inadvertently included in the claim set, and that the claim numbering has been amended accordingly.

Claims 1, 3, 6, 7, 11, 13 and 14 have been amended and new claims 15-20 have been added.

Claim 1 has been amended to provide proper antecedent basis and to otherwise improve the claim language of the last paragraph.

Claims 3, 6 and 11 have been amended slightly so that the claim language more closely comports to that recognized by the courts in connection with computer-related software-type claims. Claim 6 has also been amended to correct an antecedent basis problem and to improve the claim language in the last paragraph.

Claim 7 has been amended to change the preamble so that the claim is directed to a method of operating a QKD system instead of a method of exchanging a key, and also to correct a minor typographical error.

Claim 13 has been amended to correct a minor typographical error.

Claim 14 has been amended so that the phrase "single-photon detector" is used consistently throughout, and to improve the preamble language.

None of the amendments to the claims have been made for purposes of patentability over the cited prior art.

#### **1. Claim Objections**

Claims 1, 6 and 12 (now properly numbered as claim 13) were objected to by the Examiner because of informalities.

Specifically, claims 1 and 6 were objected to because the phrase "the detector gating pulse" lacks antecedent basis. Claims 1 and 6 have been amended to replace this problematic phrase with the phrase "the detector gate pulse," which has proper

antecedent basis.

Also, the semicolon at the end of claim 13 has been replaced by a period.

In view of these minor amendments, Applicant respectfully submits that claims 1, 6 and 12 are in condition for examination and respectfully requests the withdrawal of the objection to these claims.

## 2. Claim rejections under 35 USC §101

Claims 6, 11 and 12 stand rejected under 35 USC §101 as directed to non-statutory subject matter of software *per se*. The Examiner asserts that these claims lack the necessary physical articles or objects to constitute a machine or manufacture within the meaning of 35 USC §101.

Applicants respectfully traverse this rejection.

The recent case of *In Re Bilski*, 545 F.3d 943 (CAFC 2008) addressed the issue of what constitutes statutory subject matter under 35 USC §101 for process claims. The court in *In Re Bilski* set forth a two part test that reads as follows (emphasis added): “an applicant may show that a process claim satisfies §101 either by **showing that his claim is tied to a particular machine**, or by showing that his claim transforms an article.” *In Re Bilski* 545 F.3d at 961. Note that only one of these two conditions needs to be met in order to satisfy the test.

The preamble to Applicants’ claim 6 as amended reads as follow (emphasis added):

A computer-readable medium having instructions embodied therein to direct a **computer** in a **quantum key distribution (QKD) system** to execute instructions to perform the following method of performing autocalibration of **a single-photon detector** arranged to detect weak photon pulses in the QKD system:

Claim 11 has essentially the same preamble.

The above preamble language used by the Applicants is entirely consistent with the terminology required by the courts for claims directed to software-related inventions, and so cannot serve as a basis for rejecting the claims under 35 USC §101. See, e.g., *In re Beauregard*, 35 USPQ2d 1383, 1384 (Fed. Cir. 1995) (“The Commissioner now states ‘that computer programs embodied in a tangible medium, such as floppy diskettes, are patentable subject matter under 35 USC section 101 and must be examined under 35 USC §§102 and 103”).

The preamble of claim 12 reads as follows (emphasis added):

A method of autocalibrating **a single-photon detector** in a **quantum key distribution (QKD) system** having a **controller**, comprising:

Clearly, each of claims 6, 11 and 12 are tied to a **particular machine**—namely, a **QKD system**—and are in fact further tied to a **single-photon detector** in the machine. The relationship of the claim steps to the machine is more than incidental. The various acts in the claims define a way of operating the QKD system (i.e., the “machine”) in a manner that optimizes its performance by maintaining a maximum number of photon counts as detected by the single-photon detector during QKD system operation. This is a physical result based on the operation physical “articles” of the QKD “machine”

It is manifestly clear from the claim language that the claimed method is not set forth in “function descriptive material,” but rather is set forth in concrete and definite terms that yield **physical results** in a **QKD system** — the results generally being: a) the **determination** of an **optimal arrival time  $T_{MAX}$**  of the **detector gate pulses** that corresponds to an **optimum number of photon counts** from a **single-photon detector**, and b) the **dithering** of the **arrival time  $T$**  of the **detector gate pulses** to **maintain the optimum number of photon counts**. This allows the **QKD system** to be **autocalibrated**—which is the ultimate physical result of the various intermediate physical results of a) and b), above.

Applicants respectfully submit that in view of the above, claims 6, 11 and 12 are unmistakably directed to statutory subject matter under 35 USC §101 because

they clearly satisfy the “machine” part of the two-part test recently enunciated in *In Re Bilski* for determining whether a process claim is direct to statutory subject matter. Applicants therefore respectfully request withdrawal of the claim rejections under 35 USC §101.

3. Non-statutory double-patenting rejection

Claims 1, 6 and 7 stand provisionally rejected on the grounds of nonstatutory double patenting over claims 1, 5 and 7 of co-pending Application No. 10/589,419.

A Terminal Disclaimer and fee is provided herewith that obviates the non-statutory obviousness-type double patenting rejection, and Applicants respectfully request entry and acceptance of the Terminal Disclaimer and the withdrawal of the nonstatutory double patenting rejection.

4. Claim rejections under 35 USC §112

Claims 7-10 stand rejected under 35 USC §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention.

Claim 7 has been amended so that the preamble reads: “A method of operating a quantum key distribution (QKD system....” This eliminates reference to exchanging keys and thus the need to include steps in the claim directed to exchanging keys.

Applicant respectfully submits that the amendment to the preamble of claim 7 renders claims 7-10 definite under 35 USC §112, second paragraph, and so respectfully requests withdrawal of the indefiniteness rejection of these claims.

5. Claim rejections under 35 USC §102

Claims 1-13 stand rejected under 35 USC 102(b) as being anticipated by the article by Bethune and Risk, entitled “An autocompensating fiber-optic quantum cryptography system based on polarization splitting of light” (hereinafter, “Bethune”).

“Anticipated” means that all of the elements and limitations of a given claim are described in a single prior art reference. See e.g., *Akzo N.V. v. U.S. Int’l Trade Comm’n*, 808 F.2d 1471, 1479 (Fed.Cir.1986) (“Under 35 U.S.C. § 102, anticipation requires that each and every element of the claimed invention be disclosed in a prior art reference.”)

Applicant respectfully submits that the Examiner has adopted an overly expansive view of the nature and scope of the disclosure of Bethune, and that a closer reading of Bethune reveals that an anticipation rejection of the claims based on Bethune is inappropriate because Bethune does not teach all of Applicant’s claim limitations. As such, Applicant traverses the rejection of the claims.

By way of review, Bethune is directed to (emphasis added) “a system for quantum key distribution (QKD) ... that **passively compensates** for time-dependent variations in the fiber-optic path due to stress, temperature or bi-refrindexence.” See *Abstract*, page 340, col. 1, lines 1-5; *Conclusion*, page 346, col. 2, lines 1-4. The teaching of Bethune is directed to a QKD system that has a very specific detector configuration that utilizes a very specialized circuit for pulse-biasing the particular type of single-photon detector used.

As described in the section entitled “*B. Single Photon Detection*” starting on page 342, col. 2, Bethune discusses how he makes use of a particular type of single-photon detector, namely a reversed-biased avalanche photodiode (APD), where the reverse bias is set to be above the reverse breakdown voltage. To reduce the rate of thermally triggered avalanche breakdowns, the detectors are cooled and are pulse-biased above breakdown for as short an interval as possible by providing very short electrical pulses to the detector (e.g., 3.3 volt bias pulses of 1.5 ns in duration). Bethune uses a specially designed circuit (shown in Fig. 2(a)) that allows for short bias times and reliable detection of small photon-induced charge pulses through the use of two bias pulses. This in turn allows for a single APD to be used to monitor photons arriving in coincidence with either of the two bias pulses.

Note that the aforementioned **bias** pulses provided to the detector are not **detector gate pulses**. The bias pulses are used to reduce the rate of thermally triggered avalanche breakdowns. The plot of Fig. 3(a) plots the detector “Count

Rate” versus the bias pulse delay (ns). Here, the “bias pulse delay” is the (time) difference between the **electronic bias pulse** and the **photon arrival time**. The plot simply shows that a bias pulse delay of about 37 ns gives a maximum detector count rate. Said differently, providing a bias pulse to the detector 37 ns after the expected photon arrival time provides the best detection for the given SPD arrangement.

Applicants note here that the Examiner misinterprets Fig. 3(a) when he associates it with the Applicants’ claim limitation relating to varying the timing of the **detector gate pulse** provided to the **detector**. In actuality, the plot of Fig 3(a) applies only to the **limited case** of providing a **bias pulse** to an **APD-type detector** that is connected to **highly specialized bias-pulse circuitry**.

Applicants’ claims do not include any limitations that the single-photon detector be subject to a bias pulse, or that it includes or otherwise constitutes an APD-type detector. In fact, in Applicant’s invention, and APD-type detector can be used **without the bias pulses and without the accompanying specialized circuitry of Bethune**.

Rather, Applicants’ claimed invention relies on the use of **detector gate pulses** S3 provided at various times to the **detector** to establish an optimal arrive time for the pulse . In particular, the “arrival time T” of the detector gate pulse is varied over a first range R1 to determine an optimal arrival time  $T_{MAX}$  that corresponds to a first optimum number of photon counts from the single-photon detector. This is not taught in Bethune.

Applicants’ claimed invention also calls for **dithering the detector gate pulse** by varying the arrival time T over a second range R2 surrounding  $T_{MAX}$  to maintain either the first optimum number of photon counts or a second optimum number of photon counts. Again, there is **no teaching** in Bethune directed to **controlling the timing of detector gate signals to maintain an optimum number of photon counts**.

Applicants’ claimed invention **actively** maintains QKD system performance (and can be said to **actively** compensate the QKD system) by scanning the detector gate pulse arrival time over a first time interval and then dithering the detector gate pulse timing over a second time interval. In contrast, in Bethune **no active**

***compensation is required.*** See, e.g., Conclusion, page 346, col. 2, lines 1-4).

Thus, by definition, Bethune cannot be said to teach Applicants' active scanning and dithering claim limitations as they relate to the operation of the single-photon detector in a QKD system.

In view of the above, Applicants respectfully submit that Bethune cannot reasonably be said to teach all of the claim limitations in Applicants' pending claims and so cannot be said to anticipate Applicants' claimed invention. Applicants therefore respectfully traverse the anticipation rejection under 35 USC §102(b) and request the withdrawal of the anticipation rejection of claims 1-14, and the allowance of pending claims 1-20.



## CONCLUSION

Claims 1, 6 and 13 have been amended to overcome the objection to these claims, and withdrawal of the objection is respectfully requested.

Applicants respectfully submit that, for the reasons stated above, Claims 6, 11 and 12 clearly constitute statutory subject matter under 35 USC §101 and respectfully request that the non-statutory subject matter rejection be withdrawn.

A Terminal Disclaimer is provided herewith that obviates the provisional non-statutory obviousness-type double patenting rejection of claims 1, 6 and 7, and acceptance and entry of the Terminal Disclaimer and withdrawal of the rejection is earnestly requested.

Claims 7-10 have been amended to overcome the rejection based on 35 USC § 112, second paragraph, for indefiniteness, and withdrawal of the indefiniteness rejection is respectfully requested.

Applicants respectfully submit that for the reasons set forth above claims 1-20 as presently presented are patentable over the cited art of Bethune, and withdrawal of the anticipation rejection under 35 USC 102(b) and the issuance in due course of a Notice of Allowance for the pending claims is respectfully requested.

The Examiner is encouraged to contact the Assignee's authorized representative at 941-378-2744 to discuss any questions that may arise in connection with this Reply.

Respectfully Submitted,

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